

NOBLE GASES IN LOONGANA-TYPE (CL) AND UNGROUPED CARBONACEOUS CHONDRITES.

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Introduction: Carbonaceous chondrites (CC) showing discrepancies from the features of the main groups are classified as ungrouped CCs (C-ung) [1]. The diverse mineralogies, petrologies and chemical compositions result in the lack of systematic classification. This extends to the states of alteration, with petrologic types ranging from aqueously and/or thermally altered to pristine. Studies have linked a depletion of mainly trapped Ar, Kr and Xe relative to primitive samples to aqueous alteration experienced by the CCs [e.g. 2, 3]. We aim at further exploring the effects of both aqueous and thermal alteration on the noble gas compositions of C-ung samples, along with studying genetic links between these meteorites and to the main CC groups.

The association of samples initially classified as C-ung with sufficiently similar features can lead to the formation of a new group. Such is the case for the newly defined Loongana-type CC group (CL) [4]. The group is currently composed of five samples (Coolidge, Loongana 001, Northwest Africa (NWA) 13400, Los Vientos (LoV) 051, NWA 033), with some of the main defining features being the low matrix and high chondrule modal abundances, chemical evidence of thermal metamorphism and unique $\epsilon^{54}\text{Cr}-\epsilon^{50}\text{Ti}$ values distinguishing the CLs from other CCs [4]. The CLs display isotopic similarities to CKs and CVs, e.g., for Cr and O, indicating a possible formation at comparable heliocentric distances [4]. Our noble gas investigation offers further insights into the genetic links between CLs and potential further candidates, the effect of thermal metamorphism experienced by type 3.9–4 CCs, and adds to the CL's established characteristics. Given their similarities to the CLs, the analysis of CKs offers a basis of comparison.

Methods: 22 C-ung (type 1–4), 4 CLs (type 3.9–4), 2 CK4s and 2 potentially misclassified CR2s (J. Davidson, pers. commun.) were analyzed. ~10–25 mg of these samples were measured for all stable noble gas isotopes (He–Xe) with the in-house built noble gas mass spectrometer “Albatros” [see 5 for details]. The samples were wrapped in Al-foil and heated at 110 °C to remove atmospheric gases. They were then melted at 1700 °C in a Mo-crucible to release noble gases. Each measurement was followed by a re-extraction step at 1750 °C, which confirmed complete degassing.

Results and Discussion: The C-ung samples display an overall trend of decreasing concentrations of trapped ^{36}Ar with increasing degrees of aqueous alteration. This correlates well with studies done on CMs, CRs, CIs and CYs [3,6,7], highlighting the similar initial presence of the carrier phase(s) throughout various CC groups and its subsequent destruction. A trend of lower concentrations of trapped Ne with increasing aqueous alteration is however not visible, with e.g. samples such as C2-ung Tarda containing more trapped ^{20}Ne than C3.00-ung NWA 14600. A matrix normalization of these two samples results in comparable concentrations, indicating that the initially observed lack of trend could partly be due to variations in the chondrule/matrix ratios.

The Ne compositions of both CK and CL samples are dominated by a cosmogenic component, with no detectable trapped ^{20}Ne except for CL3.9 NWA 13400. The cosmic ray exposure (CRE) ages of CLs (~5–48 Ma) and CKs (~5–45 Ma) are comparable and on average longer than those of the CMs [3]. Even after matrix normalization, the concentration of trapped ^{20}Ne in NWA 13400 is much lower than in CMs [3], which could result from thermal processing. This correlates well with the observations made for Ar and Xe in the CLs; the slightly less thermally altered sample NWA 13400 features higher trapped concentrations than the other CL4s. According to the olivine-spinel thermometry of Coolidge [8], this thermal processing could have taken place at maximum temperatures of ~900 °C. The lack of detectable trapped Ne in the CK4s is likely caused by their higher degree of thermal processing when compared to less altered samples like CL3.9 NWA 13400.

The paired C-ung samples MacAlpine Hills (MAC) 87300 and MAC 87301 display comparable trapped noble gas and cosmogenic ^{21}Ne concentrations, thus providing further evidence for their pairing [1]. MAC 88107 belongs to the same grouplet [1]; however, it has lower trapped noble gas and cosmogenic Ne concentrations than the other two samples. A formation of MAC 88107 on a different parent body than MAC 87300 and MAC 87301 has been suggested based on differences in their isotopic compositions [9], which would be consistent with our noble gas results.

Acknowledgments: We would like to thank K. Metzler (IfP Münster), J. Gattacceca (CEREGE) and L. Nittler (now ASU) for providing us with samples for this study.

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